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Evolution of meat quality of black pigs with the age of slaughter

PROGRESS IN NUTRITION
VOL. 13, N. 4, 292-299, 2011

TITLE
Evoluzione della qualità della carne di suini neri in base all'età di macellazione

KEY WORDS
Black pigs, meat, quality, different ages

PAROLE CHIAVE
Suini neri, carne, qualità, diverse età

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Summary
In order to study the productive aspects and the meat's chemico-nutritional quality and the acidic composition of fat from Black pigs of Basilicata in different ages, there were used 12 animals from which 4 slaughtered at 9 months, 4 at 12months and 4 at 15 months of age. All animals were reared at indoor conditions and fed with the same feed. From the obtained results, it can be seen that the slaughtering age has a positive effect on the final live body weights, always more in those older animals (165,33 kg vs 140,8 kg and 116,5 kg), on carcasses' weight, on carcasses' conformation, on the composition of carcasses' cuts, on slaughtering yields, always lower in pigs of 9 months. Moreover, raw meat at 3 days from the slaughter of 15 months of age pigs, apart from presenting a higher ($P<0,01$) and significant pH (6,58 vs 5,16 e 5,14), in comparison with those younger (12 and 9 months), is certainly ($P<0,01$ and/or $P<0,05$) redder (7,11 vs 5,35 and 3,03), less hardy (2,27 kgf/cm^2 vs 2,86 kgf/cm^2 and 3,30 kgf/cm^2) and more resistant; while, the cooked meat of 12 months of age animals is certainly ($P< 0,01$) less hard (2,22 kgf/cm^2 vs 2,85 kgf/cm^2 and 2,38 kgf/cm^2), more watery and poorer in fat (1,43% vs 2,92% and 1,80%). In general, as far as regards the fat of cooked meat, it seems that this of younger animals presents certainly ($P<0,05$) a higher quantity of SFA (39,78% vs 38,10% and 36,37%) lower percentage of MUFA (47,22% vs 50,90% and 50,07%), a higher percentage of UFA and a ratio of ω6/ω3 less ($P<0,01$) favorable, fact that it affirms also in cooked meat. In principal and as it is already reported, it can be concluded that the most appropriate slaughtering age is this of 15 months.

Riassunto
Per studiare gli aspetti produttivi e la qualità chimico-nutrizionale delle carni e quella acidica del grasso dei suini neri di Basilicata di diversa età, sono stati utilizzati 12 animali di cui 4 macellati a 9 mesi, 4 a 12 e 4 a 15 mesi di vita. Tutti gli animali sono stati allevati a regime stallino ed alimentati con lo stesso mangime. Dai risultati emerge che l'età di macellazione incide positivamente sui pesi vivi finali, sempre maggiori nei suini più anziani (165,33 kg vs 140,8 kg e 116,5 kg), sul peso delle carcasse, sul-

la conformazione delle mezzene, sulla composizione in tagli delle mezzene, sulle rese di macellazione, sempre inferiori nei suini di 9 mesi di età. Inoltre, le carni crude a 3 giorni dalla macellazione dei soggetti di 15 mesi di vita, oltre a presentare un superiore (P<0,01) e significativo pH (6,58 vs 5,16 e 5,14), rispetto a quelle dei suini più giovani (12 e 9 mesi), sono sicuramente (P<0,01 e/o P<0,05) più rosse (7,11 vs 5,35 e 3,03), meno dure (2,27 kgf/cm^2 vs 2,86 kgf/cm^2 e 3,30 kgf/cm^2) e più resistenti; mentre, la carne cotta degli animali di 12 mesi è sicuramente (P< 0,01) meno dura (2,22 kgf/cm^2 vs 2,85 kgf/cm^2 e 2,38 kgf/cm^2), più ricca di acqua e più povera in grasso (1,43% vs 2,92% e 1,80%). In generale, per quanto riguarda il grasso della carne cruda, si nota che quello dei suini più giovani presenta certamente (P<0,05) una maggiore quantità di SFA (39,78% vs 38,10% e 36,37%), una minore percentuale di MUFA (47,22% vs 50,90% e 50,07%), una più alta percentuale di UFA e un rapporto ω6/ω3 meno (P<0,01) favorevole, significatività queste che scompaiono nella carne cotta. In linea di massima e per quanto riportato, si può concludere che l'età di macellazione più opportuna sia quella di 15 mesi

Introduction

The modern consumer, thanks to the media, is always more careful at his diet and the relationship between healthy food and his physical condition and, therefore, he is oriented at high quality food and at new eco- gastronomic methods. The zootechnic section has a significant role as it is able to provide animals with thin meat, poor in cholesterol and fat with high content of polyunsaturated fatty acids of the serie ω3 whose beneficial effects on humans health have been reported by several authors (1-8). Moreover, due to the exodus of human populations from the inland areas where the agricultural productivity is low, many areas became available for zootechnical, wild life and forestry purposes, including also the set of environmental and touristic activities. For an appropriate use of all these neglected areas, and according to Giorgetti and Poli (9), there have to be used autochthonous genotype animals which have all the necessary characteristics to populate in these agricultural areas with low productivity, like high hardiness, adaptability to environmental friendly farming systems, resistance to different environmental factors but at the same time capable to provide acceptable productions of high quality and quantity; all these qualities have to be strictly depended by the animal's genotype, its sex, age, rearing and breeding system. Between all the autochthonous genotype animals like some cattle, sheep, goats, horses and other animals of hunting interest capable to make optimum use of the farm lands, it can be included this of Black Pig. For the appropriate use of these areas, it is seriously considered those of pigs like the black one, mostly because of its meat's use in humans diet both in all over the world and in Europe where in Italy its consumption has gone over this of beef; in fact, nowadays, the consumption of pigs meat is 35 kg per capita/year in comparison with this of cattle which is 25 kg per

capita/ year (10). The Black Pig is an autochthonous genotype of southern Italy and, until the immediate post- war period, it was reared with other genotypes with semi-intensive or eco- compatible rearing systems which influence its productions. This interesting genotype was threatened with extinction when the rearing system was evolved into intensive rearing systems and inside- doors farms and, therefore, there were used breeds certainly more productive and suitable for these new methods of rearing system. This pig genotype is characterized by a high rusticity and frugality which associates a discrete and acceptable capacity of production, as well as a high adaptability in grazing. Moreover, the black color of the skin protects it from the sun; it was and it still is particularly suitable for extensive and semi- extensive rearing systems where pastures and natural resources are being used. As far as regards the impact of the current rearing systems, of the breeding system as well as of the genotype, sex and age on the quanto- qualitative aspects of pig's meat, the literature is comprehensive, while for the autochthonous genotypes and those wild, even if there are many interesting notes (11-21), it is not so rich. As far as concerns the Black Pig of Basilicata, the literature is poor and it refers on the knowledge and the factors which affect the quanto-qualitative aspects of productions. For that reason, it seems useful to investigate on the influence of the slaughtering age on meat's quality.

Table 1 - Feed chemical composition (%)

Moisture		9,8
Protein		15,47
Fat		2,02
Ash		5,89
Crude Fiber		6,29
Neutral Detergent Fiber	(N.D.F.)	37,29
Acid Detergent Fiber	(A.D.F.)	6,11
Lignin		3,84

Material and methods

In order to study the influence of the slaughtering age on meat's quality of a population of Black Pig of Basilicata, there have been used 12 subject reared indoors which were divided into 3 groups of 4 animals each one, of the same age and initial live weight; there were fed *ad libitum* with an unifeed whose chemical and acid composition are reported in Table 1 and 2. The first group was slaughtered in 9 months of age, the second in 12 months and the third in 15 months of age. On every live animal were registered the food consumption, the live weights at typical ages, the average daily gain and the indexes of food conversion (Table 3). On the slaughter, there were registered the parameters reported in table 5.

Table 2 - Feed acid composition (%)

C 10:0	0,1
C 12:0	0,2
C 12:1	0,4
C 14:0	2,3
C 14:1	0,1
C 15:0	0,3
C 15:1	0,1
C 16:0	26
C 16:1ω7 tr	0,2
C 16:1ω7 cis	1,7
C 17:0	0,5
C 17:1	0,2
C 18:0	9,9
C 18:1ω9 tr	0,7
C 18:1ω9 cis	21,3
C 18:1ω7	2,4
C 18:2ω6	29,6
C 20:0	0,1
C 18:3ω3	3,2
C 20:2	0,1
C 22:0	0,2
C 20:3ω3	0,1
C 20:5ω3	0,1
C 22:5ω3	0,1
C 22:6ω3	0,1

Table 3 - Live weicht and daily gain

	9	12	15	DSE
Initial body weight	15	16,2	15,75	0,616
Final body weight	116,5 B	140,8	165,3 A	1,064
IMG	0,37 a	0,36 b	0,35 b	0,359
Daily consumptions	1,2	2,00	3,20	2,364

A, B: P<0,01; a, b: P<0,05

Table 4 - Carcass survey

	9	12	15	DSE
pH 1	6,50	6,48	6,63	0,113
pH 2	5,53	5,21	5,47	0,230
Lenght Round	57,50	60,75	59,00	2,048
Lenght carcass	102,75 bB	110,25 Ba	118,75 A	3,371
Lenght round inside	16,50 B	19,13 aA	17,63 b	0,905
Lenght round outside	14,00 B	16,13 A	14,00 B	0,759

A, B: P<0,01; a, b: P<0,05

Moreover, on every carcass, after 24 hours in refrigerator at 4°C, there were registered the data of Table 4. The right half- carcass (dx) of every subject was divided into cuts (Table 5) and on those principals was evaluated the composition of lean, fat and bones (tab. 6), following the instructions of ASPA (22).

On a sample of *Longissimus Dorsi* (LD) of each half- carcass was determined (Table 7) the pH, the colorimetric indexes L*,a* (red) and b* (yellow) with the Hunter-Lab system, the cooking loss (into an oven at 75° C inside the heart of the sample), the shear force (Warner Blazer Shear WBS), the chemical composition (Table 8) by following the instructions of ASPA (23), used also for the chemical evaluation of foods. On the extracted fat of a part of every sample (24), cooked and not, it was determined the acid composition (Table 9) with the gas- chromatography analysis- silica in glass with the stationary phase of bis- cyanopropyl- siloxane- polisililfenilen 70% (60m x 0,25mm ID x 0,25 μm). For the identification of every individual fatty acid, it was made a reference on the retention time of palmitic acid and, in doubtful cases, a standard has been used. All data collected were subjected to analysis of variance and differences between the estimated average evaluated with the "t" of Student (25).

Results and discussion

From the results, it is shown that the live weights of the animals in the end of the trial, as it was expected, are significantly different (P< 0,01 and/or P<0,05) in relationship with the age of slaughter. In fact, the older animals are those who have the higher live weights (165,33 kg), fact that determines the major weight of half- carcasses and those younger lower weights (Table 3). The age which has also affected the conformation of the carcasses (Table 4) is surely resulting (P< 0,01 and/or P<0,05) longer in these of 15 months of age in comparison with this of the others. Moreover, pigs slaughtered at 15 months of age, besides the fact that they present significantly (P< 0,01) the higher slaughtering yields in both hot and cold (95,45% e 92,75%), they have certainly (P< 0,01 and/or P<0,05) shown the least decline in refrigeration (2,81%vs 3,60% e/o 4,70%), probably due to a difference in maturity that animals get at this age (Table 5). As far as regards the percentage composition of lean, fat and bone of the principal cuts, it is noted that these of pelvic limb, in contrast at those of loin

Table 5 - Slaughtering survey

	9	12	15	DSE
Live body weight(kg)	116,60 Bb	140,75 ab	165,33 Aa	12,011
Right dx hot half- carcass (kg)	48,50 Bb	59,88 Ba	79,17 A	6,146
Left sx hot half- carcass (kg)	47,25 Bb	58,63 Ba	78,60 A	6,164
Right dx cold half- carcass (kg)	45,63 Bb	57,63 Ba	77,00 A	6,103
Left sx cold half- casrcass (kg)	45,25 Bb	56,63 Ba	76,33 A	4,973
Cooling loss weight (%)	4,07 A	3,60 a	2,81 Bb	0,440
Yield at hot (%)	82,18 B	83,92 AB	95,43 A	0,681
Yield at cold (%)	78,84 B	81,14 AB	92,75 A	0,544
Reconst. Half- carcass(kg)	46,77	57,94	76,37	6,304
Feet (%)	2,03 A	1,87 A	1,44 B	0,136
Pelvic limb (%)	28,03	27,60	24,89	3,000
Tail (%)	0,33 b	0,42	0,48 a	0,068
Kidney (%)	0,40	0,41	0,33	0,092
Flare fat (%)	1,94 a	0,57 b	1,12	0,521
Loin (%)	13,60 Ba	11,87 Bb	17,25 A	1,010
Abdominal region (%)	10,75 Bb	14,58 A	13,00 a	1,375
Neck (%)	8,34	8,82 a	6,31 b	1,554
Brisket (%)	1,65 b	2,44	2,90 a	0,616
Shoulder (%)	17,00	15,81 b	17,66 a	1,064
Jowl (%)	2,28 b	2,91 a	2,49	0,359
Head (%)	13,68 a	12,72	12,16 b	0,712

A, B: P<0,01; a, b: P<0,05

and shoulder, presents not to be significant with the age of the animal (Table 6). Indeed, the loin of the younger animals (9 months) is certainly (P< 0,01) characterized by major levels of lean (71,27%) and major percentage of bone (7,70%); while, the shoulder of these animals show certainly (P< 0,01) lower percentage of lean (71,12%) and higher levels of bone (22,04%). However, in these cuts, the incidence of fat, despite of the observed differences, does not seem to be affected by the age of slaughtering. Meat from pigs slaughtered at 9 months of age, besides having a lower and significant (P< 0,01) pH, presents also the lowest (P< 0,01 and/or P<0,05) colorimetric indexes L*(51,31), a* (3,03) and b *(10,76). The raw meat of these animals are, also, significantly (P< 0,01 and/or P<0,05) harder (3,30) and less resistant (Table 7).

As far as regards the chemical composition of the raw meat (Table 8), it is observed that this of older animals, as it was expected, in relationship with other subjects

Table 6 - Principal cuts

	Pelvic limb			Loin			Shoulder			DSE		
	9	12	15	9	12	15	9	12	15	Pelvic limb	Loin	Shoulder
Lean (kg)	10,68 bB	12,83 a	14,74 A	4,55 B	4,66 B	6,52 A	5,90 B	6,85 B	10,63 A	1,344	0,675	0,810
Fat (kg)	0,96 B	1,32	1,70 A	0,48 B	0,72 B	4,27 A	1,82	1,85	1,89	0,307	0,839	0,158
Bone (kg)	1,46 b	1,67 b	2,40 a	1,34 B	1,74 B	2,59 A	0,60	0,75	0,89	0,439	0,282	0,202
Whole weight (kg)	13,09 cB	15,82 b	18,84 aA	6,37 B	7,12 B	13,38 A	8,29 B	9,45 B	13,41 A	1,448	0,917	0,994
Lean (%)	81,50	81,08	78,18	71,27 A	65,29 A	49,00 B	71,12 B	72,54 B	79,21 A	2,166	6,740	1,936
Bone (%)	7,30	8,36	8,95	7,70 B	10,10 B	31,47 A	22,04 A	19,73 A	14,16 B	1,465	6,392	1,632
Fat (%)	11,19	10,56	12,88	21,03	24,61	19,53	7,24	7,74	6,62	2,957	3,592	1,511

A, B: P<0,01; a, b: P<0,05

Table 7 - Physical parameters

	9	12	15	DSE
pH	5,16 B	5,14 B	6,58 A	0,390
L	51,31 b	56,08 a	52,62	2,279
a	3,03 bB	5,35 a	7,11 A	1,140
b	10,76 B	12,95 A	12,88 A	0,512
Raw Hardness	3,30 a	2,86	2,27 b	0,539
Raw Resistance	1,94 B	1,98 B	2,17 A	0,075
Raw Work	0,65	0,57	0,49	0,116
Cooked Hardness	3,38 A	2,22 B	2,85	0,424
Cooked Resistance	1,57	1,60	1,52	0,182
Cooked Work	0,53 a	0,37 b	0,44	0,072
Cooking loss (%)	26,60	25,64	29,44	3,242

A, B: P<0,01; a, b: P<0,05

of lower age, results certainly (P< 0,01 and/or P<0,05) less watery (72,65% *vs* 73,72% and 73,48%) and more fatty (2,42% *vs* 1,43% and 1,80%); the same result, even with a lower level of statistic significance, it can be seen on cooked meat (Tab. 8). The major quantity of fat of older animals is due to the fact that with the age, animals come closer to adults weight and feeding is oriented mainly to adiposity storing and less at the muscular development. Moreover, fat from slaughtered animals of 9 months, in relationship with those older, is certainly (P< 0,01 and/or P<0,05) characterized by higher percentages of saturated fatty acids (39,78 *vs* 36.37) and, particularly, of lauric (0,25%), myristic (1,78%) and palmitic acid (24,73%) caused to increase the emetic lipoproteins of low density (L.D.L.) which act in favor of the formation of the erythematous plaques that increase the risk of cardiovascular dysfunctions.

The same subjects present, also, higher percentages of C18:2cnjt that decrease with the age and higher levels of total unsaturated fatty acids (58,83% *vs* 60,55% and 61,83%), monounsaturated (47,22% *vs* 50,90% and 50,07%) and a higher ratio ω6/ω3.

Pigs slaughtering age, besides the observed differences and without statistic significance, seems not to affect the content of SFA, MUFA, PUFA,UFA, ω6 and ω3 of cooked meat's fat, even if this of 9 months of age pigs, in comparison with the others, has major and significant (P<0,01) percentages of C12:0, C20:0, C18:2cnjt and lower concentrations of C17:1ω7, C18:2cnjc, C20:4ω6 and a higher ratio ω6/ω3 (Table 9).

As far as regards the concentration of C18:2cnjc, in both raw and cooked meat (tab. 9), it has a significant increase (P<0,01) with the slaughtering age and, particularly, between animals of 9 and 12 months and those of 15 months of age. The same trend can be seen, also, at C18:2cnjt that decreases with the age.

Table 8 - Chemical composition (%)

	raw			cooked			DSE	
	9	12	15	9	12	15	raw	cooked
Moisture	73,48 a	73,72 A	72,65 Bb	65,18 a	64,65	63,04 b	0,442	1,271
Protein	22,31	22,78	22,79	29,53 b	30,87	31,68 a	0,406	1,100
Fat	1,80 B	1,43 B	2,92 A	3,08	2,25	3,24	0,451	0,948
Ash	1,54 A	1,37	1,18 B	1,72	2,03 a	1,50 b	0,117	0,243
Indeterm.	0,88	0,71	0,45	0,50	0,21 b	0,54 a	0,300	0,204

A, B: P<0,01; a, b: P<0,05

Table 9 - Fatty acids (%)

	raw			cooked			DSE	
	9	12	15	9	12	15	raw	cooked
C10:0	0,12 BA	0,15 A	0,00 B	0,10 A	0,14 A	0,00 B	0,011	0,037
C12:0	0,25 A	0,20 A	0,00 B	0,22 A	0,21 A	0,00 B	0,062	0,079
C14:0	1,78 a	1,68	1,47 b	1,71	1,7	1,47	0,153	0,46
C15:0	0,05 a	0,04	0,03 b	0,04	0,03	0,03	0,009	0,021
C16:0	24,73 a	23,53	22,74 b	24,68	23,16	23,09	1,219	2,8
C17:0	0,03	0,06	0,07	0,00 B	0,00 B	0,08 A	0,058	0,005
C18:0	12,57	12,20	11,45	12,94	12,06	11,74	0,825	0,845
C20:0	0,26 A	0,25 A	0,04 B	0,31 A	0,28 A	0,06 B	0,020	0,027
C14:1	0,04 A	0,03 A	0,00 B	0,03	0,03	0,02	0,005	0,011
C16:1	2,94	3,26	2,96	2,81	3,14	2,49	0,220	0,432
C17:1	0,21	0,17	0,17	0,21	0,18	0,18	0,037	0,038
C18:1ω7	3,58 Bb	3,96 Ba	4,71 A	3,42 b	3,89	4,46 a	0,177	0,569
C18:1ω9t	0,17	0,04	0,00	0,05	0,03	0,09	0,165	0,075
C18:1ω9c	40,15	43,35	42,45	40,22	43,18	42,23	2,023	2,665
C18:2 ω 6t	0,00	0,00	0,16	0,00	0,00	0,14	0,007	0,005
C18:2 ω 6c	8,97	7,10	8,86	9,15	7,85	9,11	2,032	2,757
C18:2cnjc	0,005 B	0,06 B	0,78 A	0,05 B	0,04 B	0,78 A	0,022	0,024
C18:2cnjt	0,79 A	0,72 A	0,03 B	0,82 A	0,73 A	0,05 B	0,065	0,128
C18:3ω3	0,51	0,41	0,37	0,51	0,44	0,42	0,104	0,123
C18:3ω6	0,08 A	0,08 A	0,02 B	0,08	0,08 a	0,05 b	0,013	0,02
C20:1ω9	0,07 A	0,07 A	0,00 B	0,07 A	0,07 A	0,00 B	0,006	0,015
C20:2ω6	0,40	0,34	0,38	0,41	0,37	0,38	0,072	0,112
C20:3ω3	0,45 B	0,53 B	1,13 A	0,46	0,64	0,66	0,255	0,318
C20:3ω6	0,11	0,12	0,14	0,14	0,14	0,12	0,043	0,058
C20:4ω6	0,09	0,10	0,05	0,10a	0,08	0,04 b	0,038	0,026
C20:5ω3	0,00	0,01	0,03	0,02	0,02	0,01	0,016	0,014
C21:5ω3	0,10	0,00	0,00	0,01	0	0,03	0,044	0,027
C22:1ω9	0,01	0,01	0,01	0,01	0,01	0,01	0,011	0,015
C22:5ω3	0,02	0,05	0,02	0,06	0,08	0,09	0,040	0,046
C22:5ω6	0,02 B	0,13 Aa	0,05 b	0,12 a	0,13 a	0,06 b	0,036	0,04
SFA	39,78 a	38,1	36,37 b	40,00	37,57	36,9	1,982	3,343
MUFA	47,22 b	50,90 a	50,07	46,82	50,52	49,33	2,113	2,777
PUFA	11,61	9,65	11,76	11,94	10,61	11,83	2,493	3,403
UFA	58,83 b	60,55	61,83 a	58,76	61,13	61,16	1,862	3,468
ω6	9,68	7,87	9,49	10,00	8,65	9,79	2,172	2,954
ω3	1,09	1,00	1,46	1,07	1,19	1,20	0,374	0,457
Other Acids	1,39	1,34	1,80	1,24	1,30	1,95	0,360	0,702
ω6/ω3	8,98 A	7,87	6,77 B	9,35 a	7,22 b	8,97	0,801	1,177
SFA/PUFA	3,55	4,11	3,28	3,49	3,72	3,62	0,847	1,196
UFA/SFA	0,29	0,26	0,33	0,31	0,29	0,33	0,079	0,111
IA	0,64	0,65	0,62	0,62	0,64	0,62	0,035	0,073
IT	1,54	1,59	1,52	1,53	1,55	1,53	0,095	0,125

A, B: P<0,01; a, b: P<0,05

Conclusions

From the obtained results and from our experimental conditions for best live weight, higher slaughtering yields, heavier and best conformed carcasses, lower drop in refrigeration, greater decrease of pH and higher cuts incidence of the loin and the shoulder, it seems that the suitable slaughtering age of Basilicata Black pig is this of 15 months of age, confirmed by a superior lean content of these two cuts, by a lower resistance of their meat and, last but not least, by a favorable chemical composition and by the fatty acid composition of raw meat.

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